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**RESPONSE OF ONION PLANTS TO HUMIC ACID AND MINERAL
FERTILIZERS APPLICATION
BY**

El-Desuki, M

National Research Center, Veget., Dept., Dokki, Cairo, Egypt.

ABSTRACT

Two field experiments were carried out in the Experimental Station of National Research Center at Shalakan during the two successive winter seasons of 2002/2003 and 2003/2004 to study the effect of the combinations between four levels of humic acid application (0, 2, 4 and 6 Liter/fed.) and four levels of mineral fertilizers (0, 50, 75 and 100% of the recommended dose of NPK fertilizers application) on growth, yield and quality of onion. The obtained result clear that:

- Vegetative growth of onion plants (plant height, number of leaves / plant, diameter of bulb and neck as well as fresh and dry weight of whole plant), total and exportable bulb yield and its quality (dry weight% and TSS%) were gradually and significantly increased with increasing the level of humic acid application. However, nitrate accumulation in onion bulbs was decreased by increasing the level of humic acid application.
- Data also clear that, vegetative growth of onion plants, total yield and its quality as well as nitrate accumulation in onion bulbs were significantly increased by increasing the level of mineral fertilizers application from 0, 50, 75 up to 100% of the recommended dose of NPK application.
- As for the interaction treatments, humic acid application at 6 L./fed. combined with adding 75% of the recommended dose of mineral fertilizers gave the highest yield of onion bulbs with the best quality and reducing nitrate accumulation in onion bulb.

INTRODUCTION

Onion (*Allium cepa L.*) is one of the most important vegetable crops grown in Egypt, not only for local consumption, but also for exportation. Mineral fertilizers i.e., nitrogen, phosphorus and potassium are greatly affect on onion plant growth, bulb yield and its quality (Haggag *et al.*, 1986, Sato, 1988, Singh *et al.*, 1989, Rizk, 1997 and EL-Desuki and Sawan, 2001 all working on onion and Setty *et al.*, 1989 on garlic).

Humic acid is a commercial product contain many elements which improve the soil fertility and increasing the availability of nutrient elements and consequently increased plant growth and yield. Humic acid particularly is used to ameliorate or reduce the negative effect of chemical fertilizers. Many investigators reported that, humic acid application led to a significant increase in

soil organic matter which improving plant growth and crop production (Chen and Aviad, 1990, David *et al.*, 1994 on tomato, Hartwigson and Evans, 2000 and Hafez, 2003 on squash). Moreover, Erik *et al.*, (2000) reported that, humic acid application caused an improving onion plant growth and bulb production.

Although, the mineral fertilizers application is essential for plant growth, development and yield productivity, high level of NPK fertilizers might be decrease plant growth, bulb yield and quality and may led to an increase in nitrate accumulation in onion bulb tissues which is very dangerous on human health. Burden (1961) reported that the fatal dose in human is about 15-70 mg NO₃-N and 20 mg NO₂-N per every kilogram of adult body weight.

Thus, this study aimed to reduce the level of mineral fertilizers (NPK) application and using humic acid as a safety source of nutrient elements to produce high onion yield with best quality as well as reducing nitrate accumulation in onion bulbs.

MATERIALS AND METHODS

Two field experiments were conducted during the two successive winter season of 2002/2003 and 2003/2004 at the Experimental Station of the National Research Center in Shalakan (Kalubia Governorate). This work aimed to study the effect of the combinations between four levels of humic acid application (0, 2, 4 and 6 Liter/fed.) and four levels of NPK fertilizers (0, 50, 75 and 100% of the recommended dose of NPK fertilizers application) on growth, yield and quality of onion. The tested amount of humic acid was applied with irrigation water at two doses, first dose was added at 21 days after transplanting and the second one added after 30 days from the first one. The amount of mineral fertilizers were divided into two equal portions. First portion was applied during soil preparation and the second at 45 days after transplanting.

Humic analysis :

Product type	Liquid suspension
Density	1.25 - 1.3 Kg/L.
Solubility	> 95 %
Color	Dark brown
Humic acid	12 %
K ₂ O	3 %
Fe	0.8 %
Zn	0.8 %
Mn	0.5 %
Mg	0.02 %

Amount of minerals fertilizers application as kg/fed.:

NPK% of recommended dose	Ammonium sulphate	Calcium superphosphate	Potassium sulphate
0	0	0	0
50%	250	250	100
75%	375	375	150
100%	500	500	200

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Onion seedling cv. Giza 20 were transplanted at the first week of December in the two seasons. Seedlings were planted on ridges of 75 cm width and 4 m in length at 10 cm apart. Each plot included 4-ridges and plot area was 12 m². This experiment was arranged in split plot design in four replicates. Where humic acid treatments were arranged in the main plots and NPK fertilizers levels were distributed randomly in the sub-plots. Experimental soil was clay loame in texture with pH 8.1 and the Table (A) show NPK content of the experimental soil.

Table (A): The chemical characteristics (N, P and K) of the experimental soil.

Season	Available NPK (ppm)		
	N	P	K
2002/2003	96	29	76
2003/2004	87	24	68

Data recorded:

Vegetative growth: Random sample of ten plants from each plot were taken at 75 days after transplanting and the plant height (cm), number of leaves, diameter of bulb and nick as well as fresh and dry weight of whole plant were recorded.

Yield: Exportable yield (bulbs with 3.5 to 5.5 cm in diameter), Small size bulb (bulbs less than 3.5 cm in diameter) and Large size bulb (bulbs more than 5.5 cm in diameter) as well as total bulb yields were recorded as ton/fed.

Bulb quality: Random sample of 30 bulbs from each plot was taken and the dry weight %, TSS and NO₃-N were assayed in onion bulb. The method which described by Black (1983) was followed to determination of NO₃-N content. Total soluble solids (TSS %) were determined by using Carl Zies refractometer .

The obtained data were statistically analyzed according to the method described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Vegetative growth:

Effect of humic acid application:

Data in Table,1 clearly show that the vegetative growth of onion plants i.e., plant height, number of leaves per plant, diameter of bulb and nick as well as fresh and dry weight of whole plant were gradually and significantly increased with increasing the level of humic acid application from 0, 2, 4 up to 6 L./fed. this result may be due to the role of humic acid as a nutrient which increasing soil fertility and increasing the availability of nutrient elements as reported by (Chen and Aviad, 1990, David *et al.*, 1994 on tomato, Hartwigson and Evans, 2000). This result was agree with those reported Erik *et al.*, 2000 on onion which mentioned that humic acid application caused an improving in vegetative growth of onion plant. Moreover, the same trend was noticed by Hafez (2003) on squash.

Table (1): Effect of humic acid on vegetative growth of onion plants.

Humic acid (L./fed.)	Plant height (cm)	Number of leaves/ plant	Diameter of		Fresh weight/ plant (gm)	Dry weight/ plant (gm)
			Bulb	Nick		
First season						
0	50.07	8.21	3.07	1.84	149.45	14.93
2	50.29	8.66	3.26	1.95	163.67	15.93
4	55.90	8.78	3.37	2.06	184.85	17.22
6	57.07	9.16	3.48	2.10	207.33	19.61
L. S. D.	1.47	0.282	0.213	0.161	1.650	0.250
Second season						
0	58.82	10.06	3.73	2.24	180.59	17.59
2	59.54	10.50	4.00	2.37	197.66	18.76
4	66.93	10.80	4.15	2.49	222.99	20.05
6	68.08	11.13	4.37	2.57	250.79	23.53
L. S. D.	1.08	0.456	0.241	0.217	2.497	0.144

Effect of mineral fertilizers application:

Results in Table,2 show that the vegetative growth of onion plants expressed as plant height, number of leaves / plant, bulb and nick diameter as well as fresh and dry weight of whole plant was significantly increased by increasing the level of mineral fertilizers (NPK) application from 0, 50, 75 up to 100% of the recommended dose of NPK application during both seasons of study. This increments of plant growth by increasing mineral fertilizers application are in harmony with those reported by Setty *et al.* (1989); Singh *et al.* (1989); Rizk (1997) and EL-Desuki and Sawan (2001) all dealing with onion.

Table (2): Effect of humic acid on vegetative growth of onion plants.

NPK (percentage of recommended dose)	Plant height (cm)	Number of leaves / plant	Diameter of		Fresh weight / plant (gm)	Dry weight / plant (gm)
			Bulb	Nick		
First season						
0	46.82	7.83	3.02	1.76	144.43	14.59
50%	53.90	8.73	3.25	1.94	165.22	16.19
75%	55.57	9.08	3.36	2.04	191.61	18.20
100%	57.03	9.16	3.56	2.22	204.05	18.71
L. S. D.	1.15	0.260	0.131	0.095	1.160	0.211
Second season						
0	55.85	9.73	3.70	2.12	173.31	17.51
50%	63.99	10.55	3.92	2.33	202.43	18.93
75%	65.96	10.81	4.21	2.56	229.92	21.04
100%	67.58	11.40	4.42	2.66	246.37	22.45
L. S. D.	0.89	0.338	0.167	0.110	2.107	0.122

Effect of the interaction treatments:

Data in Table, 3 show that the vegetative growth of onion plants (plant height, number of leaves / plant, diameter of bulb and neck as well as fresh and dry weight of whole plant) was significantly affected by the interaction between humic acid and NPK fertilizers application. In this respect, the highest values of vegetative growth were recorded with the highest level of humic acid (6 L./fed.) application combined with adding the recommended dose of NPK fertilizers. However, the lowest values were recorded in case of chick treatment i.e., without applied of humic acid or NPK fertilizers. This result was true in both seasons of growth.

Yield and bulb quality:

Effect of humic acid:

Results in Table,4 clearly show that total bulb yield, exportable and large bulb yield were gradually and significantly increased with increasing the level of humic acid application from 0, 2, 4 up to 6 L./fed. However, small bulb yield were decreased by increasing the level of humic application.

As for bulb quality, dry weight percentage was increased by increasing the level of humic acid application from 0 up to 2 or 4 L./fed. and then decreased. TSS% was increased with increasing the level of humic acid application up to 6 L./fed. with no significant differences between those received humic acid at 0, 2 and 4 L./fed. as shown in both seasons. This result may be due to the role of humic acid as nutrient and increasing the soil fertility which consequently increased the vegetative growth of onion plants (Table,1). This result are in harmony with those reported by Erik *et al.* (2000) which mentioned that humic acid application caused improving in vegetative growth and yield of onion plants.

As for, nitrate accumulation in onion bulb results declared that $\text{NO}_3\text{-N}$ accumulation in onion bulbs was significantly reduced by increasing the level of humic acid application as shown in both seasons. This result may be due to the role of humic acid on increasing the soil content of organic matter which remove the negative effect of chemical fertilizer application as reported by Chen and Aviad, 1990, David *et al.*, 1994, Hartwigson and Evans, 2000 and Erik *et al.* (2000).

Effect of mineral fertilizer application :

Data in Table, 5 show that the total bulb yield, exportable and large size bulbs as well as bulb quality were significantly increased by increasing the level of NPK fertilizers application from 0, 50, 75 up to 100% of the recommended dose. On the other hand, small size bulbs was decreased by increasing the level of NPK application. This result was true in both seasons. This result reflect the response of onion plants to NPK fertilizer application as shown in Table,2 which consequently increased the total bulb yield and bulb quality. This result are in agreement with those mentioned by Setty *et al.* (1989), Rizk (1997) and EL-Desuki and Sawan (2001) all working in onion crop.

With respect to $\text{NO}_3\text{-N}$ accumulation in onion bulb tissues, results indicate that nitrate accumulation in onion bulb was gradually and significantly increased with increasing the level of NPK fertilizer application during both seasons of study. This

result may be due to increasing of the availability of mineral nitrogen in soil as a result of increasing of mineral fertilizer application. This result was agree with those reported by EL-Desuki and Sawan (2001) on onion.

Table (3): Effect of the interaction between humic acid and mineral fertilizers application on vegetative growth of onion plants.

Humic acid	NPK	Plant height (cm)	Number of leaves / plant	Diameter of		Fresh weight / plant (gm)	Dry weight / plant (gm)
				Bulb	Nick		
First season							
0	0	44.80	7.32	2.49	1.46	114.89	12.77
	50%	50.32	8.56	3.06	1.84	129.07	14.02
	75%	52.11	8.61	3.31	1.97	175.34	15.57
	100%	53.05	8.33	3.42	2.10	178.51	17.37
2	0	43.17	7.78	3.12	1.84	145.69	13.32
	50%	48.69	8.26	3.17	1.89	150.07	16.09
	75%	53.59	9.17	3.29	2.02	177.34	16.77
	100%	55.69	9.44	3.46	2.07	181.58	17.52
4	0	48.07	7.88	3.17	1.88	155.30	14.73
	50%	60.82	8.33	3.38	2.05	178.90	16.85
	75%	56.85	9.22	3.39	2.10	183.53	17.51
	100%	57.87	9.67	3.54	2.21	221.68	19.79
6	0	51.25	8.34	3.30	1.88	161.82	17.53
	50%	55.77	9.78	3.38	1.97	202.83	17.80
	75%	59.73	9.33	3.43	2.05	230.21	22.93
	100%	61.52	9.20	3.82	2.50	234.44	20.17
L.S.D.		2.29	0.520	0.262	0.190	2.320	0.421
Second season							
0	0	52.99	9.12	3.03	1.76	137.87	15.32
	50%	58.15	9.47	3.55	2.21	158.22	16.83
	75%	60.95	10.33	4.08	2.48	210.40	17.36
	100%	63.20	11.33	4.26	2.49	215.88	20.84
2	0	51.75	9.67	3.81	2.20	174.83	15.98
	50%	58.51	10.24	3.90	2.27	183.42	18.31
	75%	63.39	10.53	4.04	2.48	212.80	19.73
	100%	64.49	11.57	4.26	2.51	219.57	21.02
4	0	58.01	10.12	3.90	2.25	186.36	17.68
	50%	72.86	10.67	4.08	2.46	218.01	18.55
	75%	67.94	10.73	4.17	2.60	220.23	20.22
	100%	68.91	11.67	4.46	2.65	267.35	23.75
6	0	60.63	10.01	4.07	2.25	194.19	21.04
	50%	66.43	11.83	4.16	2.37	250.06	22.02
	75%	71.57	11.63	4.56	2.67	276.25	26.84
	100%	73.69	11.04	4.69	3.00	282.66	24.21
L.S.D.		1.78	0.675	0.334	0.220	4.213	0.243

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Table (4): Effect of humic acid on onion bulb yield and its quality.

Humic acid (L./fed.)	Bulbs yield (ton/fed.)				Bulb quality		
	Total	Exportable	Small size	Large size	D.W. %	TSS %	NO ₃ -N (ppm)
First season							
0	8.336	3.704	2.169	2.463	13.17	11.33	339.83
2	9.383	4.386	2.074	2.923	14.38	11.63	265.09
4	10.052	5.075	1.950	3.027	14.33	11.58	250.58
6	10.662	5.463	1.770	3.429	11.95	12.00	236.50
L. S. D.	0.253	0.079	0.159	0.058	0.499	0.422	1.657
Second season							
0	9.833	4.523	2.235	3.075	14.80	12.53	345.64
2	11.124	5.373	2.185	3.566	15.83	12.85	318.52
4	11.835	5.837	2.118	3.880	16.18	12.84	301.28
6	12.621	6.422	1.990	4.209	13.63	13.26	283.55
L. S. D.	0.368	0.036	0.141	0.246	0.250	0.288	0.865

Exportable: bulbs with 3.5 to 5.5 cm in diameter.

Small size: bulbs less than 3.5 cm in diameter.

Large size: bulbs more than 5.5 cm in diameter.

Table (5): Effect of mineral fertilizer application on onion bulb yield and its quality.

NPK (percentage of recommended dose)	Bulbs yield (ton/fed.)				Bulb quality		
	Total	Exportable	Small size	Large size	D.W. %	TSS %	NO ₃ -N (ppm)
First season							
0	7.612	3.262	2.232	2.118	12.32	10.96	231.83
50%	9.136	4.238	2.084	2.814	13.46	11.42	243.42
75%	10.448	5.132	1.944	3.372	13.71	12.00	316.75
100%	11.241	5.996	1.705	3.540	14.33	12.17	300.00
L. S. D.	0.085	0.059	0.059	0.047	0.243	0.434	2.614
Second season							
0	8.861	3.935	2.364	2.562	14.04	12.10	276.12
50%	10.609	5.119	2.198	3.292	15.11	12.63	292.02
75%	12.477	6.126	2.107	4.244	15.45	13.29	319.68
100%	13.465	6.973	1.860	4.632	15.84	13.45	361.17
L. S. D.	0.217	0.032	0.061	0.199	0.403	0.298	2.637

Exportable: bulbs with 3.5 to 5.5 cm in diameter.

Small size: bulbs less than 3.5 cm in diameter.

Large size: bulbs more than 5.5 cm in diameter.

Effect of the interaction treatments:

Data in Table (6) show that the total bulb yield, exportable, small size and large size bulbs as well as bulb quality were significantly affected by the interaction between humic acid and mineral fertilizer application. The highest

values of total bulb yield, exportable and large size bulb as well as TSS% were recorded with plants received the highest level of humic acid (6 L./fed) with 75% of the recommended dose of NPK application. However, the lowest values were recorded in case of the chick treatment i.e., without the addition of humic acid or mineral fertilization as shown in both seasons.

Table (6): Effect of the interaction between humic acid and mineral fertilizers application on onion bulb yield and its quality

Treatments		Bulbs yield (ton/fed.)				Bulb quality		
Humic acid	NPK	Total	Exportable	Small size	Large size	D.W. %	TSS %	NO ₃ -N (ppm)
First season								
0	0	6.293	2.420	2.372	1.502	12.14	10.50	249.67
	50%	7.120	2.892	2.227	2.001	12.87	11.00	272.00
	75%	9.510	4.248	2.172	3.090	13.10	11.83	511.33
	100%	10.425	5.258	1.906	3.261	14.55	12.00	326.33
2	0	6.890	2.851	2.273	1.766	12.31	10.67	242.00
	50%	9.367	4.230	2.126	3.010	13.99	11.33	247.67
	75%	9.944	4.564	2.090	3.290	14.37	12.17	259.67
	100%	11.333	5.899	1.807	3.627	16.83	12.33	311.00
4	0	8.389	3.699	2.227	2.463	13.53	11.00	226.33
	50%	9.834	4.791	2.121	2.922	14.42	11.33	235.67
	75%	10.420	5.335	1.886	3.199	15.18	12.00	250.33
	100%	11.567	6.474	1.568	3.525	14.19	12.00	290.00
6	0	8.877	4.079	2.058	2.740	11.31	11.67	209.33
	50%	10.220	5.038	1.860	3.322	12.56	12.00	218.33
	75%	11.917	6.382	1.627	3.908	12.19	12.00	245.67
	100%	11.637	6.354	1.537	3.746	11.73	12.33	272.67
L.S.D.		0.171	0.118	0.119	0.095	0.486	N.S.	5.228
Second season								
0	0	7.316	2.993	2.469	1.854	13.91	11.55	296.27
	50	8.198	3.628	2.293	2.277	14.44	12.23	326.40
	75	11.389	5.202	2.279	3.908	14.72	13.02	365.60
	100	12.427	6.267	1.898	4.261	16.13	13.30	394.27
2	0	8.055	3.499	2.431	2.125	14.11	11.73	289.07
	50	10.854	5.069	2.228	3.356	14.78	12.63	298.20
	75	11.928	5.824	2.216	3.887	16.57	13.45	313.60
	100	13.658	7.098	1.865	4.695	17.86	13.57	373.20
4	0	9.820	4.399	2.365	3.056	14.91	12.20	269.93
	50	11.357	5.575	2.172	3.609	16.97	12.47	283.47
	75	12.403	6.074	2.081	4.248	16.89	13.33	303.73
	100	13.760	7.301	1.852	4.607	15.96	13.37	348.00
6	0	10.255	4.852	2.190	3.213	13.24	12.90	249.20
	50	12.027	6.205	2.096	3.726	14.24	13.20	260.00
	75	14.188	7.405	1.851	4.932	13.63	13.37	295.80
	100	14.017	7.226	1.824	4.966	13.41	13.57	329.20
L. S. D.		0.434	0.064	0.122	0.399	0.807	N.S.	5.273

Exportable: bulbs with 3.5 to 5.5 cm in diameter.

Small size: bulbs less than 3.5 cm in diameter.

Large size: bulbs more than 5.5 cm in diameter.

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As for nitrate accumulation, result clear that NO₃-N accumulation in onion bulb was significantly affected by the interaction treatments, the highest values were recorded with plants receiving humic acid at 2 liter/fed. with adding 100 % of the recommended dose of mineral fertilizer application. But the lowest values were recorded with those received 6 liter/fed. of humic acid with adding zero or 50% of the recommended dose of mineral fertilizer application during the first and second season respectively. This result may be due to the role of humic acid on increasing the soil content of organic matter which remove the negative effect of chemical fertilizer application as reported by Chen and Aviad, 1990, David *et al.*, 1994, Hartwigson and Evans, 2000 and Erik *et al.*, 2000.

Finely, from the previous mentioned results we could concluded that using 75% of the recommended dose of NPK application (375 kg ammonium sulphate, 375 kg calcium superphosphate and 150 kg potassium sulphate) with adding humic acid application at 6 L./fed. were recommended to obtain the highest bulbs yield with the best quality and reducing nitrate accumulation in onion bulb.

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استجابة نباتات البصل لإضافة حمض الهيوميك والسماذ المعدني

محمد السوقي محمد

قسم بحوث الخضار - المركز القومي للبحوث - الدقي - القاهرة

أجريت تجربتان حقليتان في مزرعة المركز القومي للبحوث بشلقان - محافظة القليوبية خلال الموسم الشتوي لعامي ٢٠٠٢/٢٠٠٣ و ٢٠٠٣/٢٠٠٤. وذلك لدراسة تأثير التفاعل بين أربعة مستويات لإضافة حمض الهيوميك (٠، ٢، ٤، ٦ لتر للفدان) وأربعة مستويات من السماذ المعدني (٠، ٥٠، ٧٥، ١٠٠% من توصية وزارة الزراعة لإضافة النتروجين والفوسفور والبوتاسيوم) على نمو وإنتاجية نباتات البصل وكانت أهم النتائج كما يلي :

• أوضحت النتائج أن النمو الخضري متمثلا في طول النبات - عدد الأوراق - قطر البصلة - قطر العنق - الوزن الطازج والجاف للنبات وكذلك المحصول الكلي للأبصال والمحصول الصالح للتصدير وأيضا جودة الأبصال (النسبة المئوية للمادة الجافة - محتوى الأبصال من المواد الصلبة الذاتية) قد زاد زيادة تدريجية ومعنوية بزيادة إضافة حمض الهيوميك . في حين أن تراكم النترات في الأبصال قل بزيادة إضافة حمض الهيوميك .

• أوضحت النتائج أيضا أن النمو الخضري والمحصول وجودة الأبصال وكذلك تراكم النترات في الأبصال قد زاد زيادة معنوية بزيادة مستوي السماذ المعدني المضاف. أوضحت النتائج أيضا أن إضافة حمض الهيوميك (٦ لتر للفدان) مع إضافة ٧٥% من التوصية السماذية أعطى أعلى محصول وأفضل جودة للأبصال مع تقليل تراكم النترات في الأبصال.